PROBABILISTIC MODELLING AND REASONING

III Semester: CSE(AI & ML)								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACAC01	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	1	0	4	30	70	100
Contact Classes: 45	**Tutorial Classes: 15**	**Practical Classes: Nil**				**Total Classes: 60**		
Prerequisites: Python Programming								

I. COURSE OVERVIEW:

Context information is gathered from a variety of sources that differ in the quality of information they produce and that are often failure prone. The pervasive computing community increasingly understands that developing context-aware applications should be supported by adequate context information modeling and reasoning techniques. These techniques reduce the complexity of context-aware applications and improve their maintainability and evolvability. This course provides a study of probabilistic modeling, inference and learning in a logic-based setting.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic principles of probability and random variables.

II. The skills of extracting probabilistic models from the data with the help of continuous probability distributions and Gaussian approach.

III. The estimation statistics and decision making techniques, algorithms which plays vital role in data mining.

IV. The Bayesian process of inference in probabilistic reasoning system.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1	Calculate the singular value decomposition of a given matrix and principal components of a given covariance data matrix for reducing the dimensions.	Apply
CO 2	Apply normal moments, mean, variance, skewness and kurtosis of Gaussian distributions in the geometrical analysis of a data set which follows Gaussian distributions.	Apply
CO 3	Interpret the role of the log likelihood function and maximum likelihood estimate in determining the estimates of Binomial, Poisson distribution parameters.	Understand
CO 4	Identify Cramer-Rao Lower Bound in calculating minimum variance unbiased estimator.	Apply
CO 5	Make use of decision theory and estimation statistics, EM algorithm in finding maximum likelihood parameters of a statistical model.	Apply
CO 6	Utilize Bayesian laws, methods, and entropies in solving the inference problems and optimizing the information.	Apply

IV. SYLLABUS:

MODULE – I: MATRIX DECOMPOSITION AND DIMENSION REDUCTION ALGORITHMS (09)

Principal Component Analysis- Population Principal Components, sample principal coefficients, covariance matrix of data set, Dimensionality reduction, Singular value decomposition, Gram Schmidt process.

MODULE – II: CONTINUOUS DISTRIBUTIONS AND GAUSSIAN MODELS (09)

Continuous distributions: normal distribution-MGF, cumulant generating function, skewness, kurtosis, exponential distribution-memory less property, Gaussian distribution.

MODULE – III: MAXIMUM LIKELIHOOD PARAMETER ESTIMATION (09)

Maximum likelihood estimate (MLE) - log-likelihood function-Binomial, Poisson, Cramer-Rao Lower Bound (CRLB) and applications, minimum variance unbiased estimator (MVUE).

MODULE - IV : DECISION THEORY (09)

Decision functions, basic concepts, the loss function, minimax, expected utility principle**,** point estimation and interval estimation**,** the Neyman-Pearson lemma as a decision theoretic result, mixture models and the EM algorithm.

MODULE - V : BAYESIAN METHODS FOR INFERENCE AND IFORMATION THEORY (09)

Deriving the likelihood function, Bayes' rule ,Statistical tests and Bayesian model comparison, Bit, Surprisal, Entropy, Source coding theorem, Joint entropy, Conditional entropy, Kullback-Leibler divergence.

V. TEXT BOOKS:

1. S. C. Gupta, V. K. Kapoor, "Fundamentals of Mathematical Statistics", S. Chand & Co., 12th Edition, 2016.
2. Giovanni Parmigiani, Lurdes Inou, "Decision Theory Principles and Approaches", Wiley Publication, 2009.

VI. REFERENCE BOOKS:

1. I.T. Jolliffe, "Principal Component Analysis", Second Edition, Springer publications, 2002.
2. Richard Arnold Johnson, Irwin Miller, John E. Freund, "Probability and Statistics for Engineers", Prentice Hall, 8th Edition, 2013.
3. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2012.

VII. WEB REFERENCES:

1. https://mbb-team.github.io/VBA-toolbox/wiki/Bayesian-modelling-introduction/
2. https://www.coursehero.com/sitemap/schools/2655-University-of-Edinburgh/courses/1641949-INFORMATICPMR/#
3. https://www.webdepot.umontreal.ca/Usagers/perronf/MonDepotPublic/stt2100/Decision_theory.pdfhttps://cse.iitk.ac.in/pages/CS698X.html
4. http://www.cs.toronto.edu/~yangxu/information-theory-v3.pdf
5. http://www.stat.cmu.edu/~larry/=sml/Bayes.pdf